PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

An Electric Machine having Permanent Magnets Mounted in the Rotor between its Pole Segments

We, SIEMENS AKTIENGESELLSCHAFT, a German Company of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an electric machine having permanent magnet excitation, the rotor of which consists of laminated segments in which permanent magnets are mounted. As magnets, there are employed ceramic permanent magnets which are connected in parallel in pairs and which are radially or at least approximately radially traversed by flux. With such an arrangement, large permanent magnet magnets having to be employed.

According to the present invention there is provided an electric machine including a rotor assembly which is mounted on a rotor shaft and which comprises laminated segments, permanent magnets disposed between said segments and a starting cage of non-magnetic electrically conductive material, all of the segments of one polarity being formed of a plurality of continuous laminations, each said lamination having a circular aperture through which said shaft is inserted, and all of the segments of the opposite polarity being formed of a plurality of laminations spaced apart from the first mentioned laminations and separated therefrom by the magnets, said assembly being held together by said cage.

With this construction it is not necessary for the motor shaft to consist of a non-magnetic steel or be provided with a brass distance sleeve. The magnets may be of block or arcuate form. Instead of a starting cage consisting of copper bars, one consisting of a pressure casting is employed, which affords a considerable saving of cost. At the same time, the cast cage serves to hold together the laminated segment assembly, so that pins for screwing or riveting the laminated segments together are not necessary. The laminated segments are advantageously so stamped that they are initially still joined at their periphery. The individual discs are then threaded on, the magnet blocks and the shaft are pushed into position and the starting cage is cast in. Only then are the individual segments separated by slitting the webs, which may take place either in the course of the outside turning of the rotor assembly or by slitting or milling. The magnitude of the stray flux may be determined by the choice of the slit width, and this may in turn influence the characteristics of the motor.

Since the rotor shaft is completely encircled by the ring which defines the aperture integrally formed in the laminated segments of one polarity, a secure mounting of the assembly is ensured. In addition, the permanent magnets are fixed in the rotor assembly by the pressure cast cage, so that no unbalances may subsequently occur due to shifting of the magnets. If desired, the short-circuiting rings, which are formed on the starting cage by casting and which connect the cage bars together, may be so constructed that they seat directly on the rotor shaft, which further assists in the retention of the assembly.

The rotor assembly may be subdivided into a number of component assemblies separated by a half of a slot pitch. Intermediate short-circuiting rings are provided between the cage bars of the individual components assemblies.

In order that the invention may be more clearly understood several embodiments of the

invention will now be described, by way of example, with reference to the accompanying drawings, in which

Figure 1 shows a four pole rotor assembly having two pairs of parallel magnets.

Figure 2 shows a four pole rotor assembly having three pairs of parallel magnets,

Figure 3 shows a four pole rotor assembly having one pair of parallel magnets,

Figure 4 shows a four pole rotor assembly having one pair of arcuate magnets,

Figure 5 shows a four pole rotor having two pairs of parallel magnets,

Figure 6 shows a four pole rotor having one pair of magnets concentrically and symmetrically arranged with respect to the rotor shaft.

Referring to Figure 1, the rotor assembly consists of laminated segments 1, 2, 3 and 4, between which permanent magnets 5, 6, 7 and 8 are bedded. In addition, the magnets are so disposed in the assembly that their outer lateral edges lie in the region of the separating slits 9 between the individual segments, while there extend between the inner lateral edges of the respective non-parallel magnets, i.e. 5, 6 and 7, 8, gaps 10 and 11 filled with non-magnetic material. The opposite segments 1 and 2 of like polarity, i.e. the North poles in the present instance, are connected together by a ring 12 left in the stamping, which extends around the shaft 13. On the other hand, the segments 3 and 4 forming the South poles are magnetically separated by the gaps 10 and 11 from the shaft 13, which consists of magnetisable material. The segments are formed with slots 14 in which the starting cage 15 consisting of an aluminium pressure casting is cast. The said cage serves at the same time to hold the assembly together. In addition, the cage bars 15^1 mounted between the separating slits 9 and the outer lateral edges of the permanent magnets locate the magnets in the assembly.

Referring to Figure 2, there are again denoted by 1 and 2 the laminated segments which are fixedly mounted on the shaft 13 through a ring 12, by which they are connected, while the segments 3 and 4 have no magnetic contact with the shaft. Six magnets 16, 17, 18, 19, 20 and 21 arranged in three pairs with the magnets of each pair being arranged parallel to each other are here bedded between the segments. The arrangement is such that two non-parallel magnets, namely, 16, 18 and 17, 19 enclose in each instance a block of the third magnet pair 20, 21. Separating gaps 22 extend from the lateral edges of these enclosed magnets 20, 21 to the inner lateral edges of the other magnet blocks.

In the construction according to Figure 3, only two magnet blocks 23, 24 are employed, these being so arranged that the two ends of each block extend to the slits between the segments, which here at the same time form separating gaps 25. A similar construction is illustrated in Figure 4, but the magnets 26, 27 are here of arcuate shape. Their lateral edges extend directly to the segment slits 28.

The construction according to Figure 5 again employs four magnet blocks 29, 30, 31 and 32. These are bedded exactly radially between the laminated segments, so that their inner ends face towards the shaft 13 and the outer ends towards the segment slits 33. Two filled separating gaps 34 extend between the inner ends of magnet blocks 30 and 31 and between those of magnet blocks 29 and 32 respectively.

A final constructional example is illustrated in Figure 6, in which two arcuate magnets 35 and 36 are employed, which are concentrically disposed around the shaft 13. There is again situated between the arcuate magnets and the shaft the sheet-metal ring 12 which connects the laminated segments 1 and 2, while separating gaps 37 extend from the ends of the magnets to the segments slits 38.

Instead of the four-pole construction of the described examples, the rotor may be constructed with any other number of poles.

WHAT WE CLAIM IS:—

1. An electric machine including a rotor assembly which is mounted on a rotor shaft and which comprises laminated segments, permanent magnets disposed between said segments and a starting cage of non-magnetic electrically conductive material, all of the segments of one polarity being formed of a plurality of continuous laminations, each said lamination having a circular aperture through which said shaft is inserted, and all of the segments of the opposite polarity being formed of a plurality of laminations spaced apart from the first mentioned laminations and separated therefrom by the magnets, said assembly being held together by said cage.

2. An electric machine according to claim 1, in which short-circuiting rings, which are formed on the starting cage by casting and connect the cage bars together, are mounted on the rotor shaft.

3. An electric machine according to claim 1 or 2, in which said rotor assembly includes four magnets which are rectangular in section taken at right angles to the rotor axis, said magnets being arranged in two pairs with the magnets of each pair parallel to one another.

4. An electric machine according to claim 3 in which said four magnets are arranged such that one end of each magnet is adjacent but not on the surface of said assembly, four gaps being provided extending from said surface to said ends respectively and two further gaps being provided between the other ends of the magnets of each pair of non-parallel magnets respectively.

5. An electric machine according to claim 1 or 2, in which said rotor assembly includes six magnets which are rectangular in section taken at right angles to the rotor axis, said magnets being arranged in three pairs with magnets of each pair parallel to one another,

one magnet of one of the pairs being disposed between but separate from two magnets one from each of the other two pairs and the other magnet of said one pair being disposed between but separated from the other two magnets, of the other two pairs, the outer ends of the magnets of the other two pairs being disposed adjacent separating slits between adjacent segments at the surface of the rotor.

6. An electric machine according to claim 1 or 2, in which said rotor assembly includes one pair of magnets which are rectangular in section taken at right angles to the rotor axis and which are arranged parallel to each other, the rotor surface having slits between the laminated segments and there being gaps extending from the ends of the magnets to the slits.

7. An electric machine according to claim 1 or 2, in which the rotor assembly includes magnets of arcuate section taken at right angles to the rotor axis concentrically arranged around the rotor shaft each magnet extending between slits disposed in the rotor between adjacent segments.

8. An electric machine according to claim 1 or 2, in which the rotor assembly includes four magnets which are rectangular in section taken at right angles to the rotor axis and which extend radially from the rotor shaft to slits disposed in the rotor between adjacent segments, the four magnets being arranged in two pairs and respective separating gaps being provided between the inner ends of the magnets of each pair.

9. An electric machine according to claim 1 or 2, in which two magnets of arcuate section taken at right angles to the rotor axis are concentrically and symmetrically arranged with respect to the rotor shaft, gaps being provided extending between the ends of the magnets and slits disposed in the rotor between adjacent segments.

10. A method of constructing a rotor assembly of an electric machine according to any preceding claim in which each lamination is produced by stamping and the segments are left joined to each other until the starting cage is formed by casting the segments then being separated by milling or slitting.

11. A method of constructing a rotor assembly according to claim 10 in which the slit width between laminated segments is chosen for determining the magnitude of stray flux.

12. An electric machine substantially as hereinbefore described with reference to Figure 1, 2, 3, 4, 5 or 6 of the accompanying drawings.

HASELTINE, LAKE & CO.,
Chartered Patent Agents,
28, Southampton Buildings,
Chancery Lane,
London W.C.2.
Agents for the Applicants.

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1177247 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

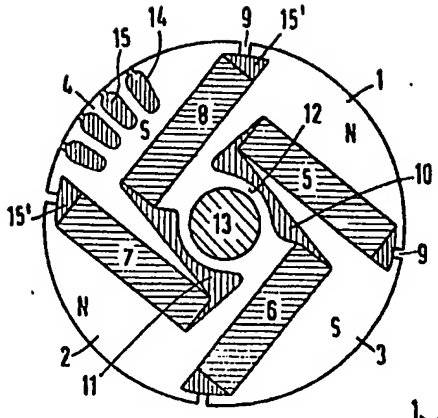

Fig. 1

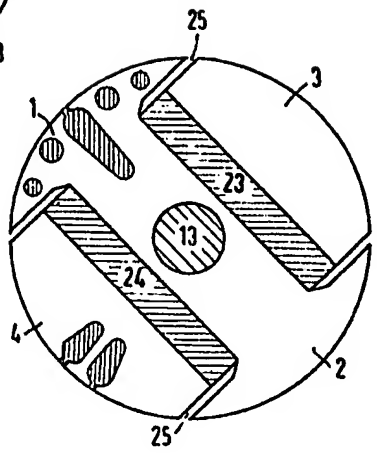

Fig. 3

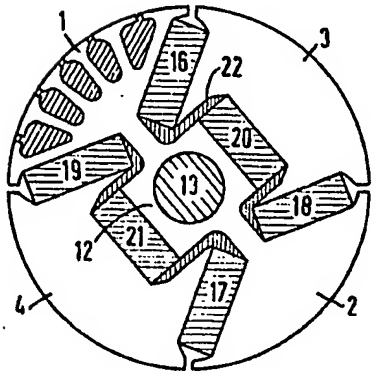

Fig. 2

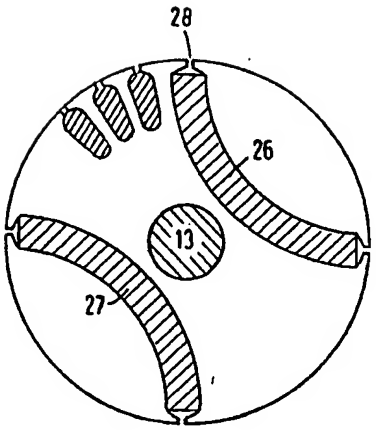

Fig. 4

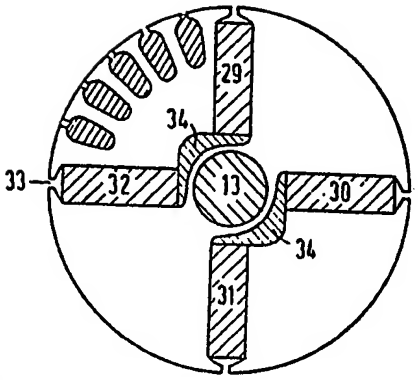

Fig. 5

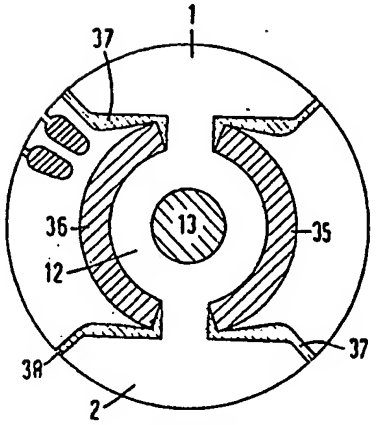

Fig. 6